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A USER-FRIENDLY TOOL TO SUPPORT SUSTAINABILITY ASSESSMENT IN THE MINING SECTOR

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ABSTRACT

While there are several frameworks available to support decision-making in the mining sector, results from the current literature showed that sustainability assessment and communication is still an emergent process in this sector, since only a few large companies have been reporting their sustainability initiatives. The results provide also evidence of the existing gap between large and small companies, with the latter showing lower levels of awareness of the impact of their activities. In this context, this research aims to contribute to an evaluation of sustainability in the mining sector and its companies, focusing in particular on aspects related to economic, social and environmental dimensions. Based on these findings, a user-friendly IT tool for sustainability assessment of mining is proposed. This IT tool provides then a graphical interface, aiming to simplify the evaluation of sustainability for public mining agencies and companies and to raise levels of knowledge and awareness within companies, towards sustainability practices and communication initiatives.

INTRODUCTION

In manufacturing process industries increasing attention has been paid to the environmental impacts of their processes and resulting products. The contribution of mining activities to economic and social development is a key discussion in mining worldwide. Over the years these activities have faced the most difficult challenges to achieving sustainability in this sector. In recent decades, environmental assessment has become commonplace in planning and evaluation at all levels in different organizations.

Nonetheless, other challenges have become imperative for the government, mining companies and communities, that is how to balance socio-economic benefits and socio-environmental conditions in this sector and how to provide useful information to decision-makers, in order to create and implement effective strategies to improve sustainability in the mining sector, taking into account the three sustainability pillars (Azapagic, 2004; Bui et al., 2017; Worrall et al., 2009). Analysis of the current literature has revealed the lack of frameworks and tools to assist mining companies in addressing sustainability assessment.

According to Devuyst (2000) sustainability assessment can be related to tools, models and frameworks that can support both decision-makers and policy-makers towards decisions about what actions they should take in attempting to make the society more sustainable. The aim of sustainability assessment is to verify which plans and activities make an positive contribution to sustainable development (Pope et al., 2017).

With regard to sustainability assessment methodologies, these are based on the identification and evaluation of criteria which expose potential impacts on the three dimensions of sustainable development: social, economic and environmental (OECD, 2010). The purpose of sustainability assessment is to provide decision-makers with an evaluation of global to local integrated nature- society systems in the short and long term, in order to assist them in determining which measures should or should not be taken in their attempt to make society sustainable (Singh et al., 2012).

In spite of all these concerns about sustainability assessment and the importance of mining sector worldwide, one of the main challenges to sustainable development in the mining sector remains as how to evaluate their activities, taking into account environmental, social, and economic aspects. In par-ticular, in developing countries, this challenge is particularity relevant since sustainability assessment in the mining sector is still not much discussed (Alves, Ferreira, and Araújo, 2018). In order to contribute to address this gap, this work sets out to explore the positive and negative impacts of mining activities, with special emphasis on proposing an IT tool which addresses sustainability assessment to assist mining companies in providing useful information to the sector.

As such, the main objective of this work is to present a new user-friendly IT toll coined Tool for Sustainability Assessment of Mining, designed to support both companies and decision makers of the mining sector on sustainability issues.

SUSTAINABILITY ASSESSMENT TOOLS AND MODELS

According to Pope et al., (2017), the concept of sustainability assessment can be used to suggest processes that are *ex-post* evaluative techniques, as well as those that are forward- looking *ex-ante* processes that intend to predict effects of an activity prior to its implementation. Tools and methodologies for sustainability assessment have been discussed in the literature in many forms.

With a view to allowing for effective planning for sustainability assessment, the OECD (2008) suggested a draft for sustainability impact assessment, where the initial process preparation consists of eleven steps for an effective sus- tainability assessment, as described in Figure **10**. Once the decision has been taken to develop the issues and objectives for assessment, all these steps together require specific infor- mation and feedback from stakeholders related to each step to allow for an initial and applicable plan for the field.

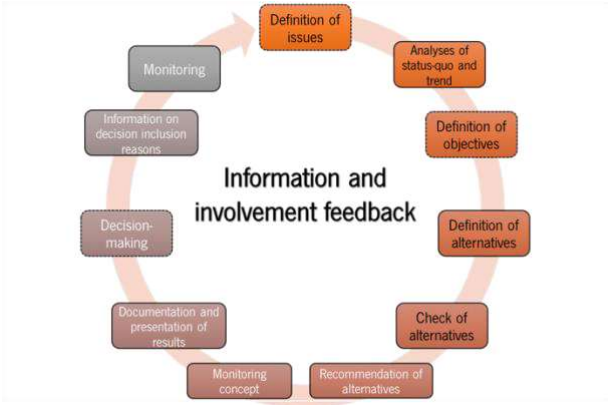


Figure 10: Preparation process for sustainability assessment. Source: adapted from OCDE (2008).

After designing an initial plan for sustainability assessment, and with knowledge of the main tools available in the current literature, specificities of the different sustainability assessment tools can be considered under a set of aspects, detailed in Figure 11.

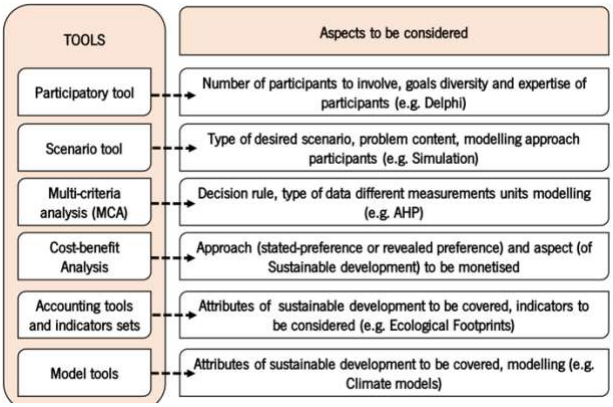


Figure 11: Sustainability assessment tools and phases of application. Source: adapted from OCDE (2010)

Notwithstanding, the tool selected for the field has to be aligned with the purpose of the assessment, while data and interested stakeholders also need to be available. The methodologies for addressing sustainability are increasingly recognised as useful in supporting policy making as well as public communication in various spheres. Information on countries and companies performance in fields such as environmental, social and economic issues, for instance, are benefits for society and companies. The effective release of this information could be achieved through the use of methodologies for sustainability assessment (Singh et al., 2009).

Yaylac and Duzgun (2016), also argue that at a strategic level, sustainability assessment is useful for quantifying and comparing the sustainability level of companies in different sectors, based on previously defined sustainability criteria. Sustainability assessment also can be one of the means by which companies and countries structure a policy problem and develop and evaluate alternative strategies to address these problems (Pope et al., 2017).

Gibson (2006), advocates that there are several reasons for the spread of sustainability assessment initiatives: a rise in awareness of interconnections among economic, social and environmental considerations; progressively evident costs and risks of unsustainable behaviour; the potential of formal commitments to sustainability and emergent consensus on the fundamentals of sustainability as the main drivers behind sustainability assessment initiatives.

With the aim of providing new insights into the topic of perception and awareness toward sustainability in the mining sector in Brazil, Alves, Ferreira, and Araújo (2018) proposed the Model for Sustainability Assessment of Mining (SAoM – model), which was applied in a set of Brazilian mining companies. The results of the application of the model for the selected companies put in evidence lower awareness for the impacts of their activities. The model was translated in a user-friendly IT tool to support its use and dissemination.

THE USER-FRIENDLY TOOL FOR SUSTAINABILITY ASSESSMENT OF MINING

Having in mind the objective of the present work, we propose an IT tool for sustainability assessment of mining based on a triple bottom line approach. In the following subsections, a detailed description of the tool is presented. The tool was developed in an excel platform using the Microsoft environment and based on the work developed by Alves, Ferreira, and Arau´jo (2016). A first version is available to download and freely used in http://w3.dps.uminho.pt/saom/. To run it the users must have installed MS Excel.

The main objective of the excel tool was to make an easy and freely to use way for companies and decision-making from mining sector in order to disseminating results and facilitate their interpretation. The tool is constituted by an interface with seven sheets. Figure 12 provides an

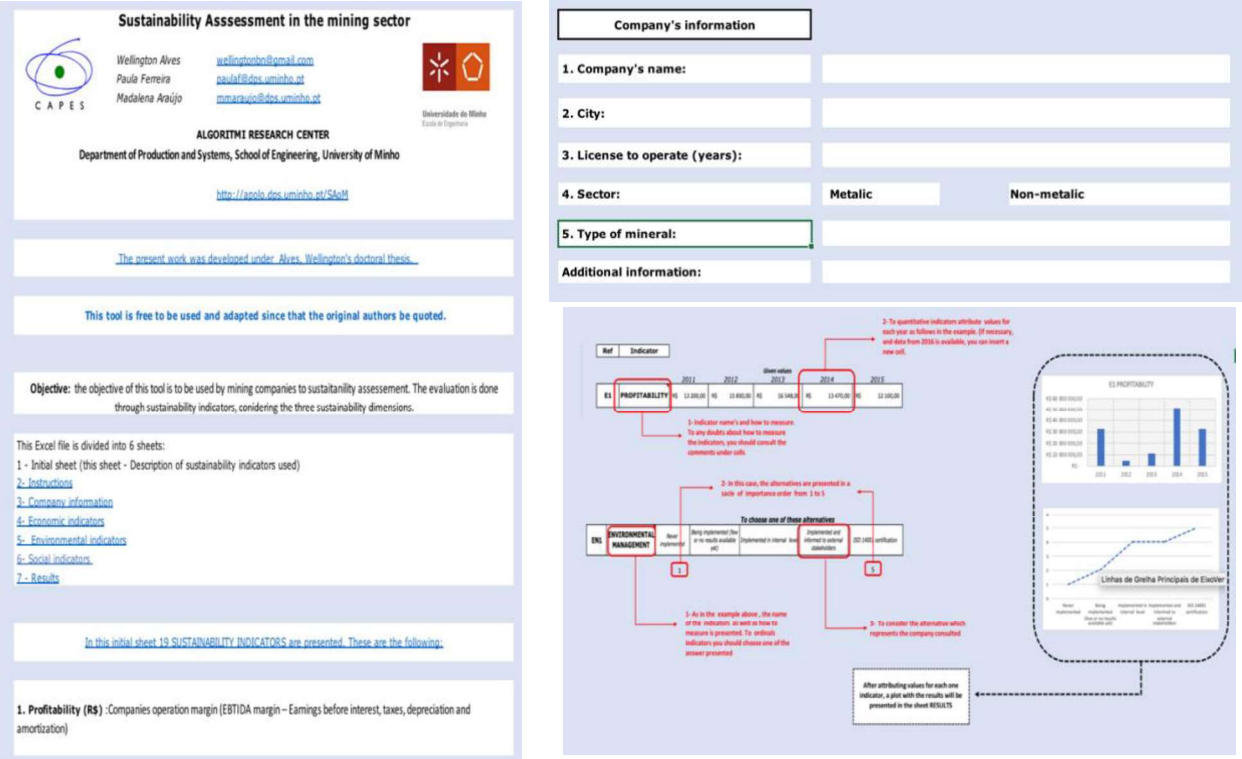


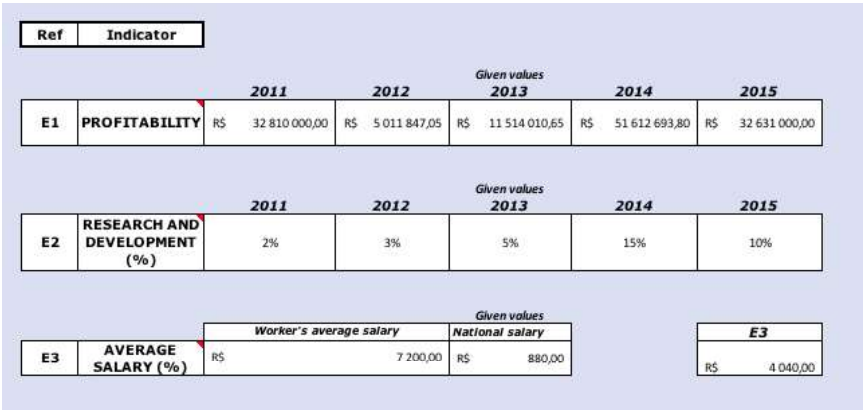
Figure 12: Interface of the Excel tool to support sustainability assessment of mining

illustration of the three initial sheets, one for general information and description of each one indicator; a second one for informa- tions on the company; a third with instructions for filling the application.

The remaining sheets, fifth and sixth others comprise the interface where the user introduces and retrieves data for each indicator for each dimension of sustainability. The last sheet plots the results achieved from each dimension filled. The plots change immediately according to the inputs of the user. Several sheets of calculations, where the information is presented, were hidden from the user to avoid confusion when using the tool. However, all calculation can be accessed on the tool or by referencing to Alves, Ferreira, and Araújo (2016), where the model attributes are described.

Economic dimension

As illustrated in Figure 13, the sheet for economic dimensions is composed by three economic indicators aiming to evaluate companies' economic performance. E1 – Profitability aims to asses companies' operating margin; E2 – Research and development is related to the percentage turnover (PT) com- panies invested in research and development (RD), including geological and social-environmental aspects, and E3 – Aver- age salary which aims to asses the ratio between workers average salary (AS) and minimum national salary.



Ref	Indicator	Given values 2011	2012	2013	2014	2015
E1	PROFITABILITY	R$ 32 810 000,00	R$ 5 011 847,05	R$ 11 514 010,65	R$ 51 612 693,80	R$ 32 631 000,00

Ref	Indicator	Given values 2011	2012	2013	2014	2015
E2	RESEARCH AND DEVELOPMENT (%)	2%	3%	5%	15%	10%

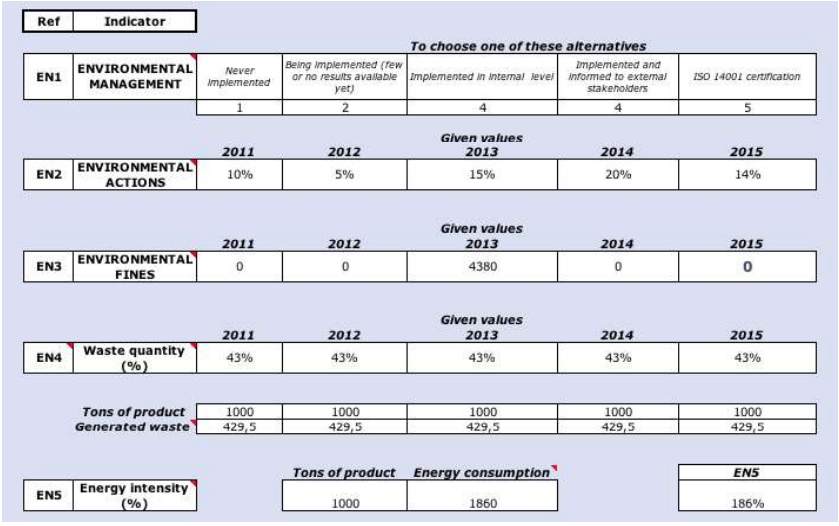
Ref	Indicator	Given values Worker's average salary	National salary	E3
E3	AVERAGE SALARY (%)	R$ 7 200,00	R$ 880,00	R$ 4 040,00

Figure 13: Example of Economic indicators for sustainability assessment of mining

In this window the user will be able to fill the required data by supplying values for each indicator for the last five years.

Environmental dimension

In this dimension the user is allowed to define the input data related to environmental concerns for the mining sector. Regarding the environmental perspective, as illustrated in Figure 14, the indicators suggested for this dimension can be adopted to measure the mining environmental performance. For this dimension the sheet discloses five indicators, namely EN1 – Environmental certification is related to the avail- ability of environmental certification; EN2 – Environmental initiatives, which focus on initiatives and the annual per- centage of the companys budget allocated to developing environmental initiatives; EN3 – Environmental fines, aiming to assess the amount of environmental fines paid by a company for non-compliance; EN4 – Waste quantity focuses on the amount of waste generated by tons of product during a company activities and on measures developed to reuse or redirect any generated waste, EN5– Energy intensity, which aims to measure the amount of energy consumed by tons of product (kWh).



Ref	Indicator	To choose one of these alternatives				
EN1	ENVIRONMENTAL MANAGEMENT	Never implemented	Being implemented (few or no results available yet)	Implemented in internal level	Implemented and informed to external stakeholders	ISO 14001 certification
		1	2	4	4	5

		Given values				
		2011	2012	2013	2014	2015
EN2	ENVIRONMENTAL ACTIONS	10%	5%	15%	20%	14%

		Given values				
		2011	2012	2013	2014	2015
EN3	ENVIRONMENTAL FINES	0	0	4380	0	0

		Given values				
		2011	2012	2013	2014	2015
EN4	Waste quantity (%)	43%	43%	43%	43%	43%

	Tons of product	1000	1000	1000	1000	1000
	Generated waste	429,5	429,5	429,5	429,5	429,5

		Tons of product	Energy consumption	EN5
EN5	Energy intensity (%)	1000	1860	186%

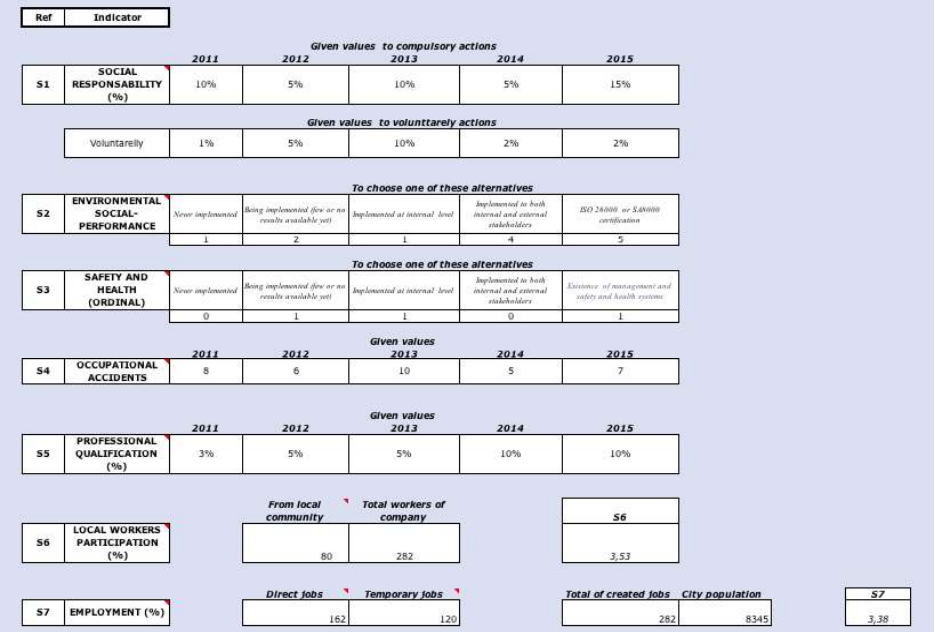
Figure 14: Example of Environmental indicators for sustainability assessment of mining

Social dimension

The potential negative impacts of mining on society, namely geographical and cultural negative effects such as air and land pollution resulting from toxic products released during extraction and other related processes and water contamination, have been considered in the literature as one of the major challenges faced by mining activities worldwide; social concerns still persist as a difficult issue to be addressed by many mining companies.

Due to the diversity of impacts which can emerge from these activities to society, the developed tool has considered social indicators in order to asses aspects in their operations as well as developing initiatives to minimize negative impacts in the surrounding local communities.

For this dimension five main indicators are suggested as follows, S1 - Social responsibility, the user are asked to fill out the percentage of company turnover (PT) invested in socio-responsibility initiatives, including both compulsory and voluntary measures; S2 - Environmental social-performance which focuses on the implementation of mea- sures for the evaluation of their socio-environmental performance, where the user is asked if standard certification such as ISO 26000 (Guidance on Social Responsibility) or SA800 (Social Accountability) are in place; S3 - Safety and health indicator aiming to analyse the existence of management and safety and health systems in the company; S4 - Occupational accidents being related to the assessment of the total number of occupational accidents, and S5 - Professional qualification which proposes to analyse whether the company considers the possibility or has in fact applied a percentage turnover (PT) of the company to invest in professional qualification. After entering the inputs for each indicator for each dimension (economic, environmental and social), the Excel tool calculates the results for each indicator (S1 – S7) and presents an overview of the results achieved. For each dimension the tool for sustainability assessment of mining presents the graphs for acknowledging the relative importance for each dimension based on the indicators.



Ref	Indicator					
		Given values to compulsory actions				
		2011	2012	2013	2014	2015
S1	SOCIAL RESPONSABILITY (%)	10%	5%	10%	5%	15%
		Given values to voluntarely actions				
	Voluntarelly	1%	5%	10%	2%	2%
		To choose one of these alternatives				
S2	ENVIRONMENTAL SOCIAL-PERFORMANCE	Never implemented	Being implemented (few or no results available yet)	Implemented at internal level	Implemented to both internal and external stakeholders	ISO 26000 or SA8000 certification
		1	2	1	4	5
		To choose one of these alternatives				
S3	SAFETY AND HEALTH (ORDINAL)	Never implemented	Being implemented (few or no results available yet)	Implemented at internal level	Implemented to both internal and external stakeholders	Existence of management and safety and health systems
		0	1	1	0	1
		Given values				
		2011	2012	2013	2014	2015
S4	OCCUPATIONAL ACCIDENTS	8	6	10	5	7
		Given values				
		2011	2012	2013	2014	2015
S5	PROFESSIONAL QUALIFICATION (%)	3%	5%	5%	10%	10%
		From local community	Total workers of company			S6
S6	LOCAL WORKERS PARTICIPATION (%)	80	282			3,53
		Direct jobs	Temporary jobs		Total of created jobs	City population
S7	EMPLOYMENT (%)	162	120		282	8345

S7
3,38

Figure 15: Example of Social indicators for sustainability assessment of mining

Additionally, the user has access to information about the perceived economic, social and environmental impacts of the company, which allows some conclusions to be drawn on priorities defined and the required strategies and measures to further improve the overall result for each dimension.

DISCUSSION

The contribution of mining activities to economic and social development is a key discussion in mining worldwide. Over the years these activities have faced the most difficult challenges to achieving sustainability in this sector. Nonetheless, analysis of the current literature has revealed the lack of frameworks and tools to assist mining companies in addressing sustainability assessment. The work of Alves, Ferreira, and Araújo (2018) has addressed this gap exploring the positive and negative impacts of mining activities in Brazil. Additionally the Model for Sustainability Assessment of Mining (SAoM - Model) was operationalized through an IT tool here presented.

The previous section described the IT tool for sustainability assessment of mining, pointing out the basic sustainability indicators to be used in order to evaluate sustainability in the mining sector.

For demonstration purposes Figure 7 presents a print screen of application of the tool for a real case. The case corresponds to a mining company operating in Brazil. The outcome of the tool application presented helps to assess the reality of the situation on the ground, having contributed to analysing sustainability in the mining sector by means of a real-life case. After analysing the results from the IT tool application for each sustainability dimension, for user has access to an an overview of the overall sustainability level for each company. This allows for the design of policy implications for both the companies and this specific case, Brazilian mining sector as a whole.

As illustrated in Figure 7, the IT tool could provide useful outcomes if used by mining companies, leading to significant results for sustainability assessment and thus bringing to light new evidence for industrial decision-makers and policy makers and contributing to a better understanding in the mining sector, as well as tackling the challenge of sustainability assessment in small and medium mining companies.

Figure 16: Interface of the Excel tool to support sustainability assessment of mining

Additionally, the user has access to information about the If applied to a set of companies, it is expected that the obtained results can be representative and illustrative of the pattern and awareness of the companies, according to the Triple-Bottom-Line approach, and key-factors to evaluate sustainability for these mining companies can be disclosed.

CONCLUSIONS

Sustainability reports are considered to be effective means to increasing communication with stakeholders, as well as contributing to the effective implementation of impact assessment procedures and the subsequent minimization of environmental and social damage caused by miming companies. Analysis of the current literature has revealed the lack of tools to assist mining companies in addressing sustainability assessment. As such, in the light of this challenge, tools to support both companies and decision-making of the mining
sector are deemed to be essential and discussion in this direction have been emerging in recent years. This research aimed to contribute to making the concept of sustainability easier to recognize and value by mining companies. For this, an IT tool for a simplified but effective assessment of their performance was developed.
The tool is based on a set of indicators, and includes the three pillars of sustainability, in order to contribute to an effective assessment and management in the sector. This should encourage mining firms to increase their sustainability assessment reporting and, as such, to engage them in their striving for more sustainable practices.
The tool was then tested in a real case study using the proposed tool in a Brazilian mining company. The assessment of the consulted company covered the three sustainability dimensions. This exercise allowed to show the potential for application of the user-friendly tool developed in a simple Excel tool for facilitating data collection, visualization and communication with stakeholders.
The tool will help to identify strategies that companies have used or can use to improve their sustainability and will promote the increasing sustainability performance of each company over time it will allow also benchmarking comparisons. If implemented, it should deliver evidence-based knowledge for promoting sustainable business models in the mining sector.

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